# Erosion Protection of Delta In-Channel Islands

**A Delta In-Channel Island Work Group**
**Project : Funded by CALFED**

The reclamation of historical swamplands, present water management practices and various ongoing erosion forces in California's Sacramento-San Joaquin River Delta have resulted in accelerated rates of erosion losses, especially for in-channel islands. Delta in-channel islands are fragments of the original Delta not excavated by river channelization and levee construction. Delta in-channel islands are disappearing due to erosion caused by wind-generated waves, boat wakes, and amplified tidal flows and fluvial currents. To explore options for arresting the erosion of in-channel islands, and the unique habitats they support, the Delta In-Channel Island Workgroup (DICIW) initiated a Demonstration Project to test biotechnical wave and erosion control structures. The biotechnical erosion control structures were constructed primarily of organic materials (wood, brush and root wads) and installed in various combinations along three in-channel islands. The dominant inter-tidal vegetation on these islands is bulrush, locally called tules (*Scirpus californicus* and *S. acutus*). Natural erosion control is achieved by tules

**Tules and peat dislodged due to the undercutting of an in-channel island. The eroded piece has floated ashore.**

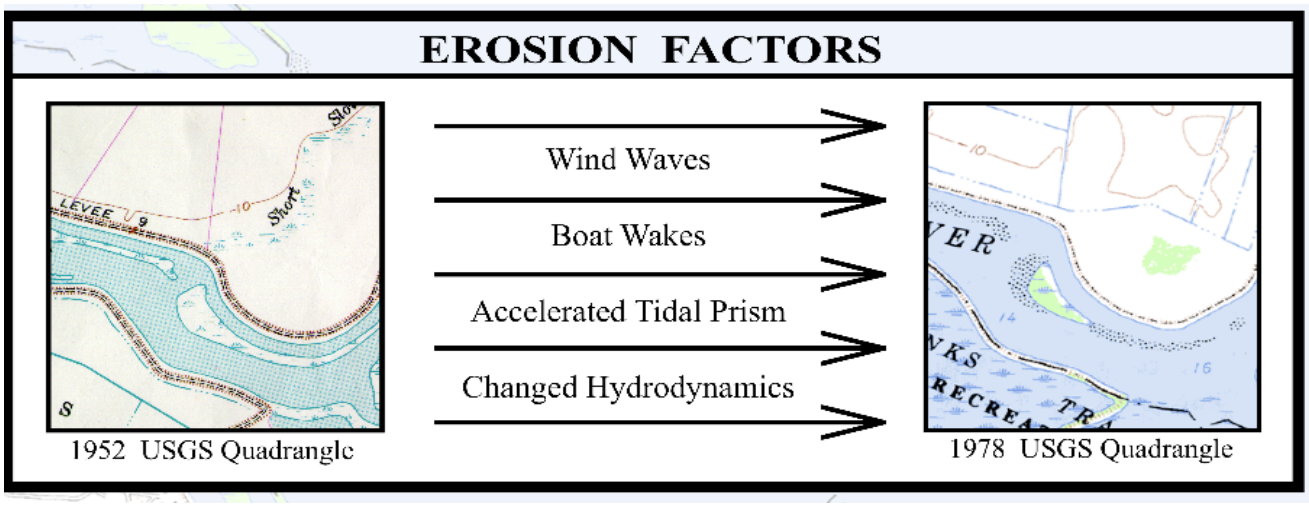

**Tules growing behind root wads installed along in-channel island off of Webb Tract to attenuate wave erosion and support tule growth.**

which grow in the intertidal zone and function as "ecosystem engineers." The tule culm is fast growing, flexible under wave impact, and the rhizomes are tenacious at resisting erosion. The "old growth tules" persisting with their extensive rhizomes on in-channel islands are remnants of the vast Delta ecosystem. The remnant tule populations surviving on in-channel islands are continuing to be lost due to erosion and undercutting.

The project was designed to provide conditions favorable for the growth of the tules as critical ecosystem engineers that provide the abiotic and biotic environment essential for the existence of upland and aquatic species. With the State's renewed focus on protecting and improving habitat conditions in the Delta, especially tidal wetlands, the lessons learned from this demonstration project should have broad application for ongoing and future restoration efforts.

## BACKGROUND

Relict Sacramento-San Joaquin Delta in-channel islands are remnants of the once vast tidal wetlands of the Sacramento-San Joaquin River estuary. On February 13, 1996, the San Francisco Estuary Project and the Delta Protection Commission convened a meeting with representatives of citizen groups, consulting companies, state and federal resource agencies and other interested parties to discuss




**Summary of erosion factors that result in the loss of in-channel islands. Note the loss of in-channel island habitat from 1952 to 1978.**

the needs for developing an agreement and strategy for protecting the Delta in-channel islands. It was agreed that the function of in-channel islands must be protected and understood for the development and implementation of future Delta restoration actions. It was also recognized that there was a need to establish an interagency/stakeholder work group to approach the identified needs. The Delta In-Channel Island Workgroup (DICIW) was formed and meets regularly as a result of that initial meeting. After a series of focused meetings on the plight of the in-channel islands, the DICIW proposed a demonstration project that would test methods for protecting in-channel islands.

## THE PROJECT

The demonstration project was undertaken with support from CALFED to determine the feasibility of "environmentally friendly" structures for controlling erosion and protecting Delta habitat associated with in-channel islands. Environmentally friendly structures as an alternative to rock riprap were designed using woody materials that would provide habitat as well as protect the shore from wave and current erosion. The project also recognized the role that in-channel islands play in the protection of adjacent flood control levees by intercepting wave energy. The project had two objectives: 1) to demonstrate that the erosion of the Delta's in-channel islands can be slowed, stopped or reversed using appropriately engineered biotechnical methods; and 2) to demonstrate that biotechnical erosion control methods can be successfully installed with positive effects on important/priority organisms. DICIW selected three candidate in-channel islands for the Demonstration Project. Two of the islands are in the western Delta and the third is in the central Delta. The biotechnical wave and erosion control structures were purposely designed, built and tested at sites with different physical conditions, in different combinations. The three in-channel island test sites are:

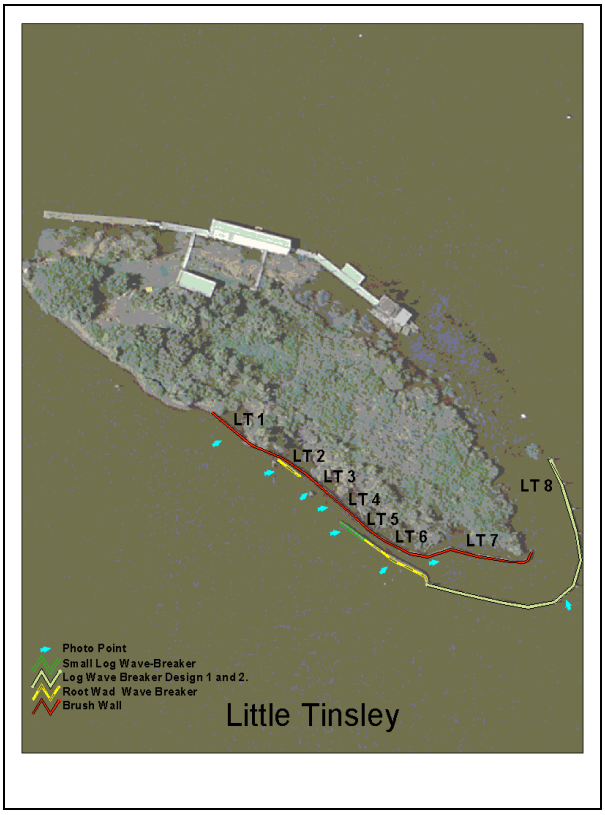

**Brush wall protecting an in-channel island with riparian vegetation.**

- Webb Tract I, a submerged tule shoal on the north side of Webb Tract, along the Stockton Deep Water Ship Channel of the San Joaquin River;
- Webb III, a small island with tule and upland habitat on the south side of Webb Tract, adjacent to Little Franks Tract; and
- Little Tinsley Island, a larger island with a complex upland habitat, along the Stockton Deep Water Ship Channel of the San Joaquin River.

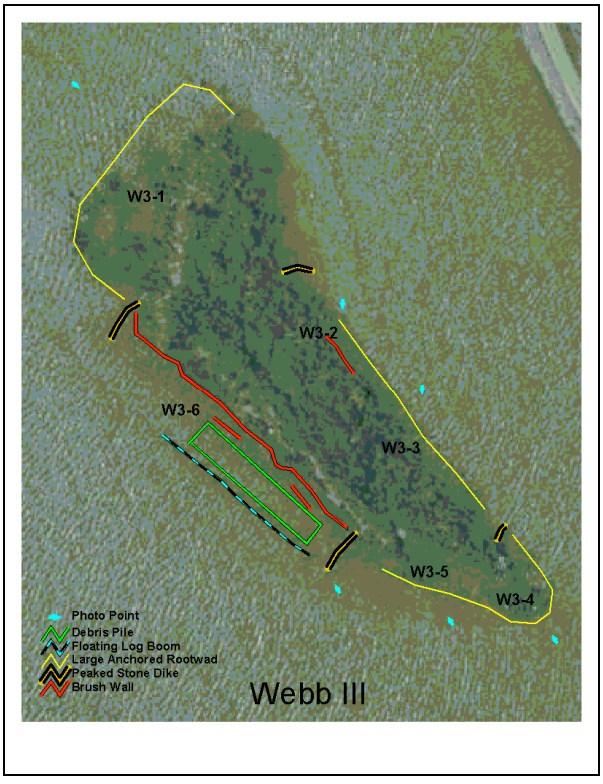

**Brush wall protecting an in-channel island with riparian vegetation.**

The DICIW design team in consultation with the US Army Corps of Engineers staff from Waterways Experiment Station proposed the following biotechnical wave and erosion control structures for this study: Brush Walls; Log Wave Breakers; Buttressed Log Wave Breaker; Small Log Wave Breaker; Rootwad Wall Wave Breaker; Large Anchored Rootwads; Floating Log Booms; Mulch Pillows (fiber mats pinned to the substrate); Tethered Floating Log Planter with Mulch Pillows and Ballast Buckets; Peaked Stone Dikes and Anchored Woody Debris Pile.

Installation of the biotechnical wave and erosion control structures was completed for Webb Tract III in October 2000, Little Tinsley Island in November 2001, and Webb Tract I in August of 2002. Adaptive management resulted in the design mimicking flood debris an Anchored Woody Debris Pile that would function as habitat and wave and erosion control.



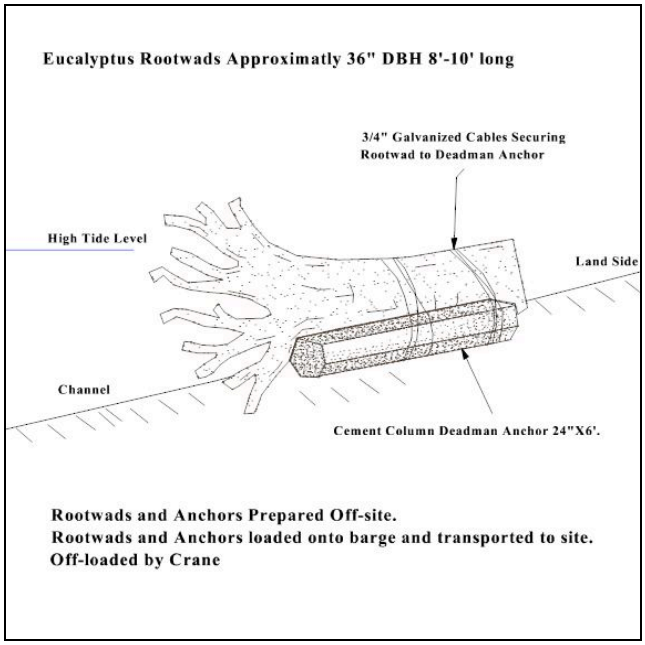

**Aerial view of the biotechnical wave and erosion control structures on Little Tinsley Island.**



**Aerial view of the biotechnical wave and erosion control structures on Webb III.**

This design was installed on Webb Tract III in 2004 and 2005. Seven hypotheses were tested and monitored to evaluate the project objectives.


**Tethered Floating Log Planter with tules on a shoal in the Deepwater Shipping Channel of the San Joaquin River. The structure is designed to submerge over time.**




**Design schematic for anchored root wads.**

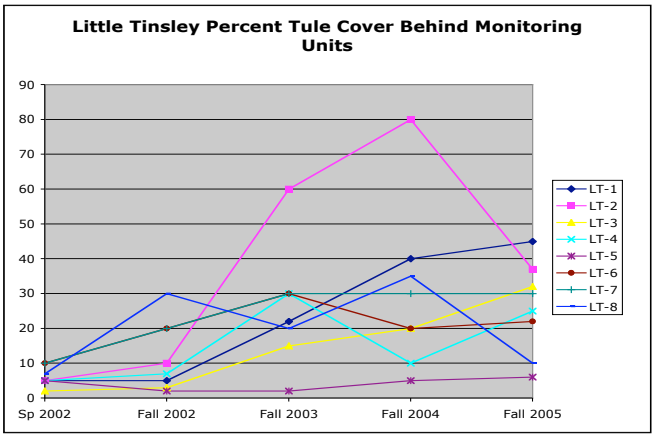
## RESULTS

Four years of monitoring show that the project objectives are supported. The project found that:

1) The erosion of in-channel islands can be slowed, stopped, or reversed using biotechnical wave and erosion control methods;

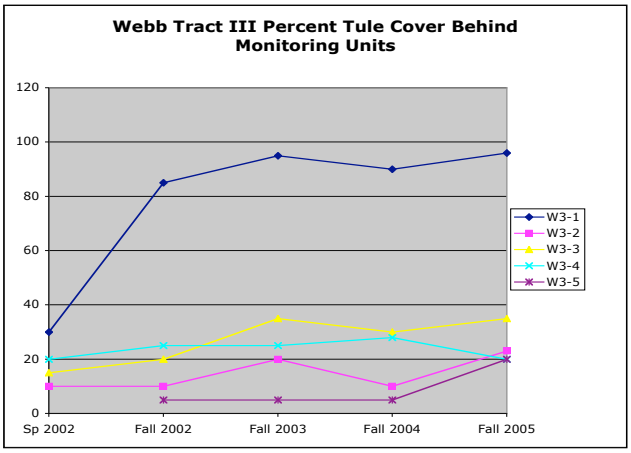
2) Biotechnical wave and erosion control methods can be successfully installed with positive effects on priority organisms (populations of two special-status plant species increased over the baseline conditions);

3) There is a positive correlation between biotechnical treatments, hydrodynamic performance, and vegetation response;




4) Tules, as ecosystem engineers, which control biotic and abiotic conditions are grow and colonize shorelines when protected by biotechnical wave and erosion control structures; and

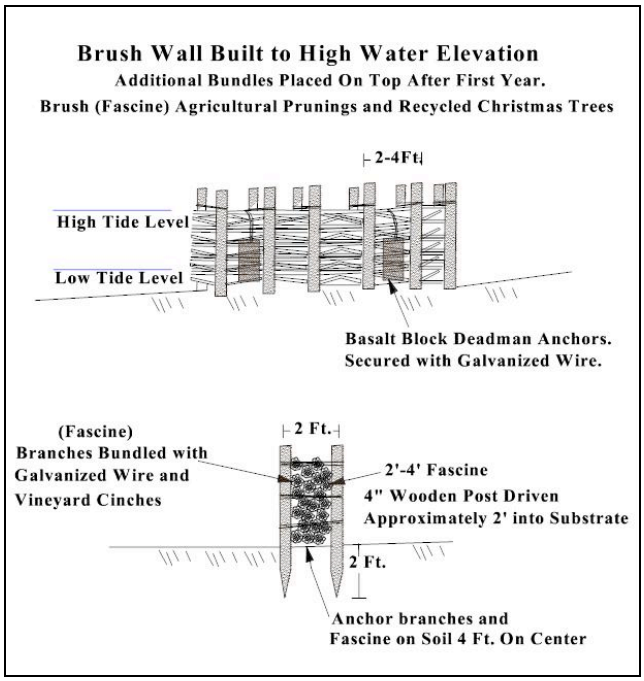
5) Hydrodynamic monitoring results show that biotechnical treatments reduce wave height by 35%-64% and reduce wave energy by 57%-87% per site.




The project has demonstrated the feasibility of

protection and restoration of Delta priority landforms and also populations of special-status species (Mason's lilaeopsis and Suisun marsh aster) using environmentally friendly biotechnical treatments. We have found that the design structures stabilize shorelines arresting erosion, sustain and enhance tule growth, and that without this project there would have been further loss of tule habitat at these sites.


**Brush Wall along the shore of an in-channel island protecting and enhancing riparian habitat.**




**Brush wall schematic illustrating materials and construction details.**

## ACCOMPLISHMENTS

The DICIW represents a broad spectrum of interests, perspectives and expertise which has led to unique solutions, adaptive management and environmentally friendly alternatives to rock riprap. The project:

- Developed and tested fourteen design structures (biotechnical wave and erosion control devices) which were installed individually or in combination;
- Advanced the understanding of biotechnical methods for erosion control and shoreline stabilization in the Delta;
- Developed long-term, positive relationships among resource management agencies, regulatory agencies, resource consultants and stakeholder groups;
- Provided protection for a remnant natural feature in a drastically altered ecosystem;
- Improved understanding of the hydrodynamics of biologically suitable erosion control structures;
- Contributed to the body of knowledge for the protection and restoration of shallow water, riparian and emergent marsh habitat along in-channel islands of the Delta;
- Advanced techniques for bank and shoreline stabilization and revegetation in the Delta;
- Contributed to Delta habitat enhancement objectives of the San Francisco Estuary Project's Comprehensive Conservation and Management Plan;
- Contributed to CALFED Ecosystem Restoration Program and Levee System Integrity Program objectives for the Delta;
- Protected and enhanced habitat for Federal and State listed aquatic and terrestrial species;
- Stabilized existing natural breakwaters (in-channel islands) that protect adjacent levees from boat wake and wind generated wave erosion;
- The DICIW has proposed criteria that would guide the development of modular structures using recycled agricultural trees and trimmings that would potentially reduce installation costs (DICIW Call for Action Position Paper); and
- Received an "Outstanding Comprehensive Conservation and Management Plan

Implementation Award" at the State of the Estuary Conference 2003.


**Brush wall protecting habitat along the shore of Little Tinsley Island.**

## LESSONS LEARNED

Shorelines in the Delta are exposed to variable physical forces dependent on location, exposure, elevation, and substrate. This demonstration project attempted to recognize the variable physical forces at the site and match the fix to the problem. The lessons learned include the following:

1) There are no historic records of the biology, ecological role or acreage of in-channel islands nor are there records of the rates of loss over time.

**Brush Wall installed along the exposed shoreline that allows for the reestablishment of tules along the shore.**

2) Monitoring the growth of tules is an economic and efficient measure of success of the biotechnical structures and stability of in-channel islands.

3) Biotechnical wave and erosion control structures are successful but expensive to install and they require maintenance.

4) The erosion control structures were designed to reduce wind and boat generated waves. It must be recognized that the erosive forces or the "nick point:" changes hourly with the tides, seasonally with wind patterns, is a function of fetch, is amplified by each boat wake, is a function of the nature of the substrate, and it varies with location and vegetation on each in-channel island or water land interface.

5) Sediment accretion at the sites was negligible. The in-channel islands in this study are a product of organic accumulation and are stable as long as there is a vegetation buffer and/or minimal erosive forces. In-channel islands without a vegetation buffer and exposed to wind wave fetch and boat wakes are at risk.

6) There is a need to understand the relationship and functional role of in-channel islands as part of the Delta ecosystem. There is a lack of knowledge of the flora and fauna present and understanding the relationship of the in-channel islands to fisheries.

7) The role of woody debris in aquatic systems is recognized but there are no data for the Delta.

8) Field observations indicate that fishermen visit the project sites for fishing and birds utilize the structures for perch and feeding.

9) We propose that the strategy for protection of in-channel islands requires: a) early detection of erosion; b) wave and current reduction along the shore; c) consideration of "soft fixes" using biodegradable materials; d) tule planting behind wave and erosion control devices; and d) an aggressive program of monitoring and maintenance of wave and current reducing structures. If tules are lost and too much of the original "peatscape" is lost and/or vertical "peat banks" are exposed, restoration is problematic.

6/4/06

Further inquiries call: San Francisco Estuary Project 510-6222-2465 or Delta Protection Commission 916-776-2290 www.delta.ca.gov